MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2015/2016

TDI2131 – DIGITAL IMAGE PROCESSING

(All sections / Groups)

30 MAY 2016
9:00 a.m. – 11:00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 6 Questions only.
2. Attempt **FIVE** out of **SIX** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1 [10 marks]

A. An 8-bit gray scale image has a spatial resolution of 456 x 100 pixels.

i. Calculate the file size of this image. [2 marks]

ii. If the spatial resolution is reduced by 70% and preserving the 8-bit depth, calculate the new file size. [1.5 marks]

iii. If the intensity resolution is reduced to 5-bit and the spatial resolution of 456 x 100 pixels remains unchanged, calculate the new file size. [1.5 marks]

B. In human eyes, there are two types of receptors known as rods and cones. Differentiate the two receptors based on their concentration location and vision. [3 marks]

C. Based on the height of the tree and the distance between human eyes and tree in Figure 1 below, calculate the height of the image formation in the eye. [2 marks]

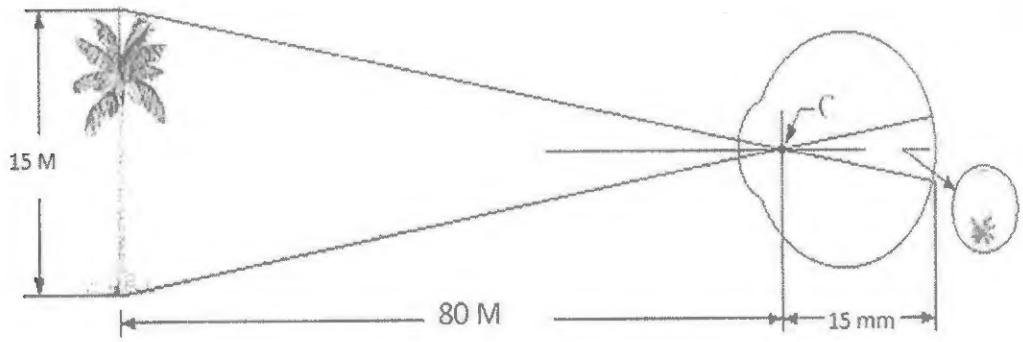


Figure 1

Question 2 [10 marks]

A. Define the three types of neighbours of a pixel. [1.5 marks]

B. Given below is a 3-bits grey value image of size 5x5 pixels.

4	4	4	4	4
3	4	5	4	3
3	5	5	5	3
3	4	5	4	3
4	4	4	4	4

Continued...

i. Plot a count table for the 3-bit grey value image [1 mark]

ii. By using the count table (from Question B.i above), calculate the probabilities of occurrence of each grey value. [2 marks]

iii. By applying the equation shown below, perform histogram equalization on the image. (Note: Show the process in table form with relevant columns). [2 marks]

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j) = \frac{(L-1)}{MN}\sum_{j=0}^{k} n_j$$

iv. Plot the corresponding equalized histogram. [1.5 marks]

v. Show the generated equalized grey values of the 5 x 5 image. [2 marks]

Question 3 [10 marks]

A. Unsharp masking is an image processing technique that has been widely used in the printing and publishing industry.

i. Explain the objective of applying an unsharp mask to an image.[1 mark]

ii. Explain (in steps) how the unsharp masking technique works. [3 marks]

B. Averaging filter is one of smoothing linear filter that can be used for blurring purpose.

i. Explain how an averaging filter works. [1.5 marks]

ii. Apply the averaging filter (3 x3 box filter) to the image below by ignoring the border pixels. [4.5 marks]

55	81	95	0	45
1	5	77	98	250
12	45	88	96	70
0	25	116	240	230
100	170	182	200	210

Continued...

Question 4 [10 marks]

A. Given the function below, complete the codes (in the shaded boxes marked I to IV) to perform the following operations: [4 marks]

```
function [myImage2]=myFunction(myImageFileName)
myImage1=imread(myImageFileName.jpg');
ABC=  [ I ]
H=    [ II ]
F=1/9*ones(3,3);
C1=conv2(H,F,'same');
[ III ]
[ IV ]
```

i. Box I: Convert the image myImage1 to the HSV color space. Assume that myImage1 is originally in the RGB color space. ABC is the variable that will store the converted image.

ii. Box II: Extract the hue component from the variable ABC and store this value in the variable H.

iii. Box III: Replace the hue component in ABC with the result of the operation conv2.

iv. Box IV: Convert the final result back to RGB color space and assign this result to the return parameter of the function.

B. For the 2-bit image given below:

0	1	1	3
2	2	1	1
3	3	1	1
0	3	3	1

i. Calculate the minimum number of bits required to code the image without compression. [2 marks]

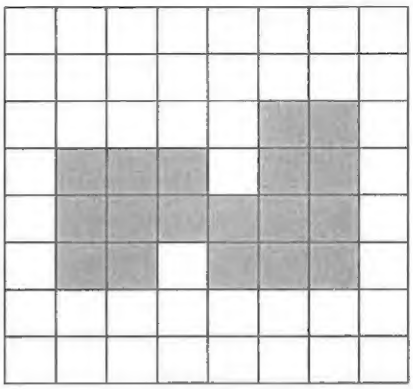
ii. Apply run-length coding on the image (Note: Write your answer in the form of sequence of pairs). [2 marks]

iii. Assuming that 2 bits are used to represent the pixel value and another 2 bits are used to represent the run length (from Question B.ii above), compute the compression ratio that can be achieved using run-length coding. [2 marks]

Continued...

Question 5 [10 marks]

A. Figure 2 below shows an image (a) and a structuring element (b) of which the origin is marked as 'x'. In (a), the dark pixels are the foreground pixels whereas the white pixels are the background pixels. Perform the morphological operation closing of the image (a) with the structuring element (b). Show your workings and intermediate results as well as the final resultant image. [5 marks]



(a)

(b)

Figure 2

B. In the codes below, the input parameter originalBW is a binary image. Based on the codes:

```
function [finalBW]=myMorphoOp(originalBW)
se = strel('disc',4,0);
erodedBW = imerode(originalBW,se);
finalBW=originalBW-erodedBW;
```

i. Describe the workings of the function myMorphoOp. (Note: You can use illustration or drawings to help clarify your description) [2 marks]

ii. Identify the name of this morphological algorithm. [1 mark]

C. Propose a way to remove the small protrusions (marked as X) in Figure 3 using morphological operations without modifying the rest of the object's shape. [2 marks]

Continued...

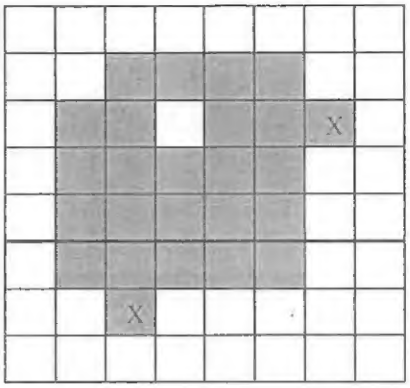


Figure 3

Question 6 [10 marks]

An image consisting of a light object on a dark background has a histogram with two dominant modes.

A. Describe how the basic global thresholding algorithm works in order to find the threshold value T that will separate the object from the background. [5 marks]

B. This image is then corrupted by Gaussian noise.

i. Explain the effect of the noise on the histogram of this image, and consequently, the result of segmentation. [2 marks]

ii. Suggest one possible way to overcome this drawback in order to segment this image successfully. [1 marks]

iii. Besides noise content, list two other factors that can affect the properties of histrogram valleys, and as a result, the success of a thresholding operation. [2 marks]

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